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**Doan**

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(54) **LIGHT EMITTING DIODE (LED) SYSTEM HAVING LIGHTING DEVICE AND WIRELESS CONTROL SYSTEM**

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**H01L 25/16** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01L 25/167** (2013.01); **H01L 2224/16225** (2013.01); **H01L 2224/48227** (2013.01); **H01L 2224/48464** (2013.01); **H01L 2224/73265** (2013.01); **H01L 2924/12032** (2013.01); **H01L 2924/13033** (2013.01); **H01L 2924/13091** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01L 25/167  
See application file for complete search history.

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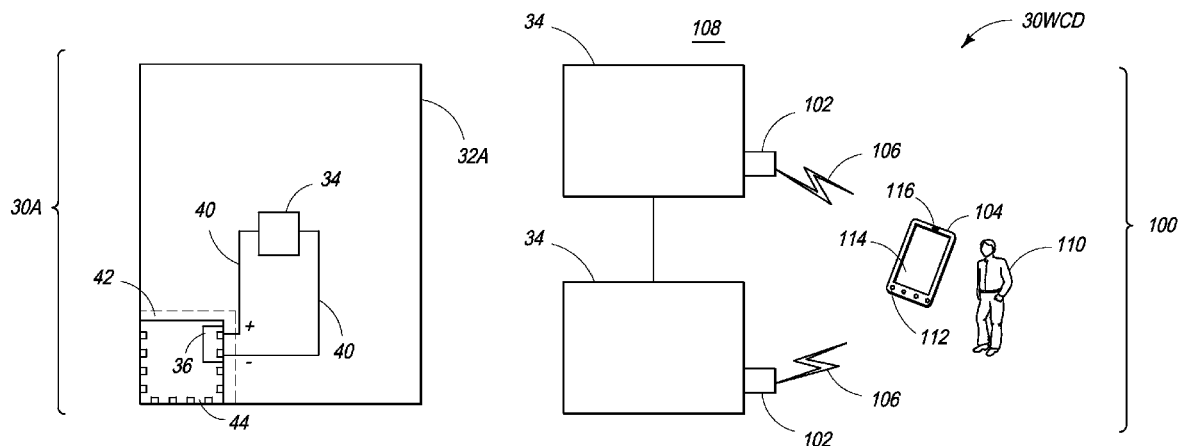
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(57) **ABSTRACT**

A light emitting diode (LED) system includes one or more light emitting diodes (LED), or other lighting devices, configured to provide lighting in an area, and a wireless control system configured to control the light emitting diodes (LED). The wireless control system includes at least one transmitter/receiver device in signal communication with the light emitting diode (LED), and a wireless control device operable by a user, configured to send input signals to the transmitter/receiver device for controlling the light emitting diode (LED), and to receive output signals from the transmitter/receiver device for indicating a status of the light emitting diodes (LED).

**15 Claims, 13 Drawing Sheets**



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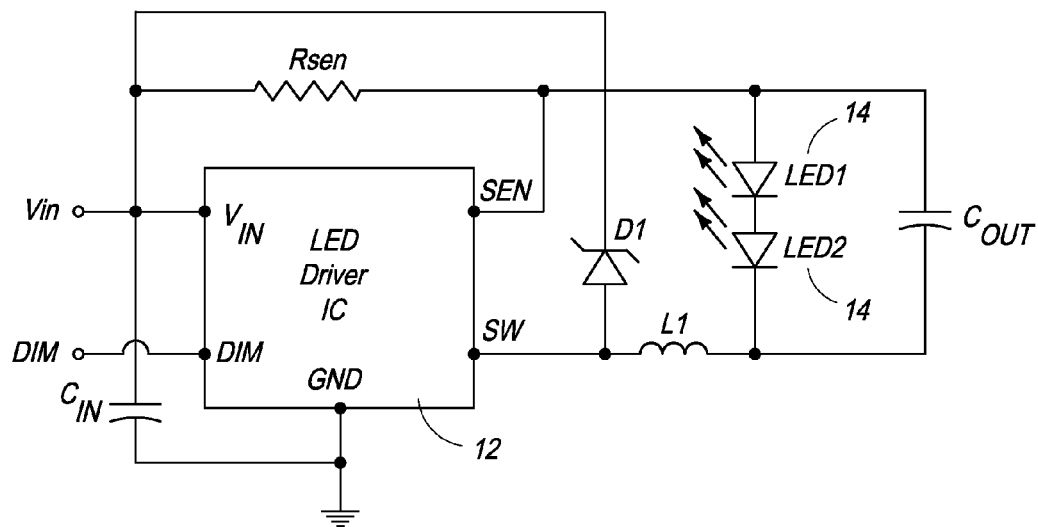
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**FIG. 1**  
(Prior Art)

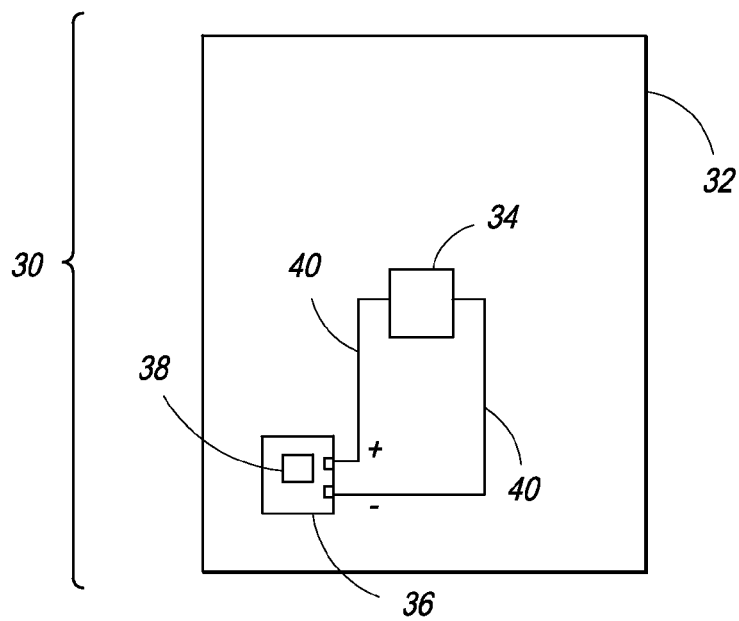


FIG. 2

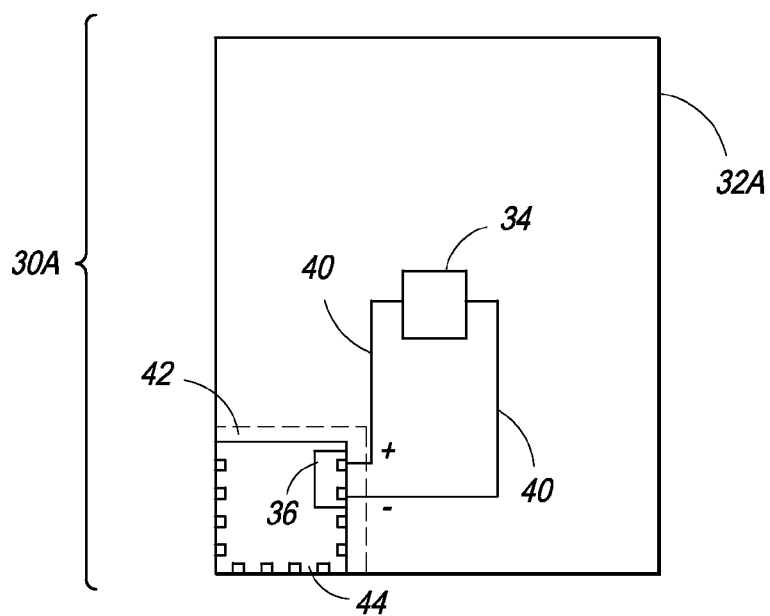
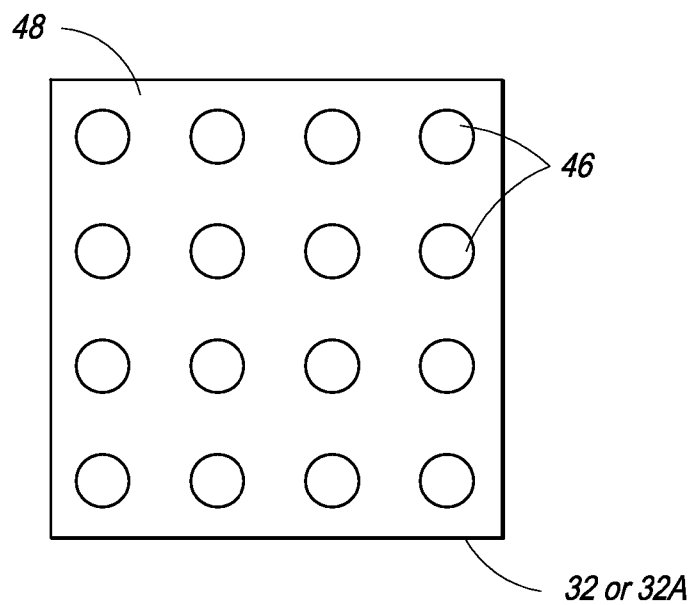
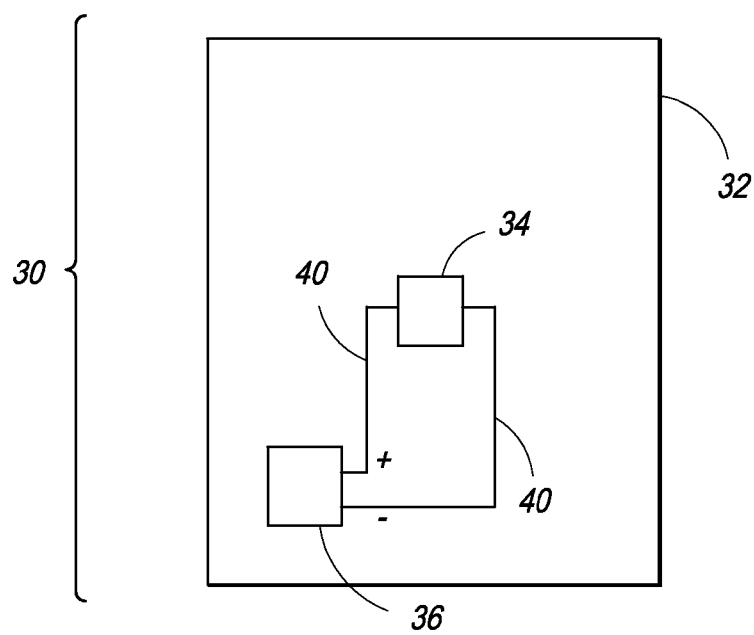


FIG. 3



**FIG. 4**



**FIG. 5**

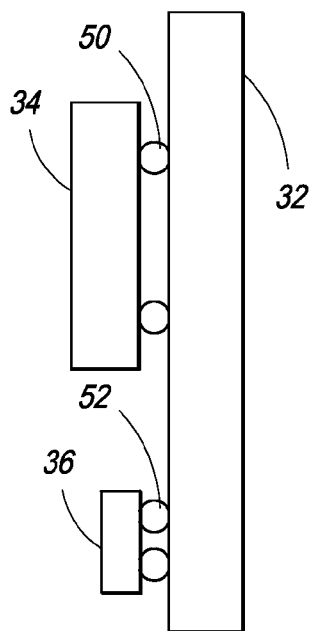


FIG. 5A

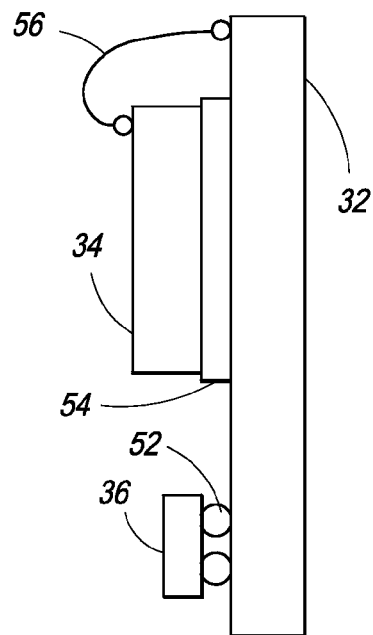


FIG. 5B

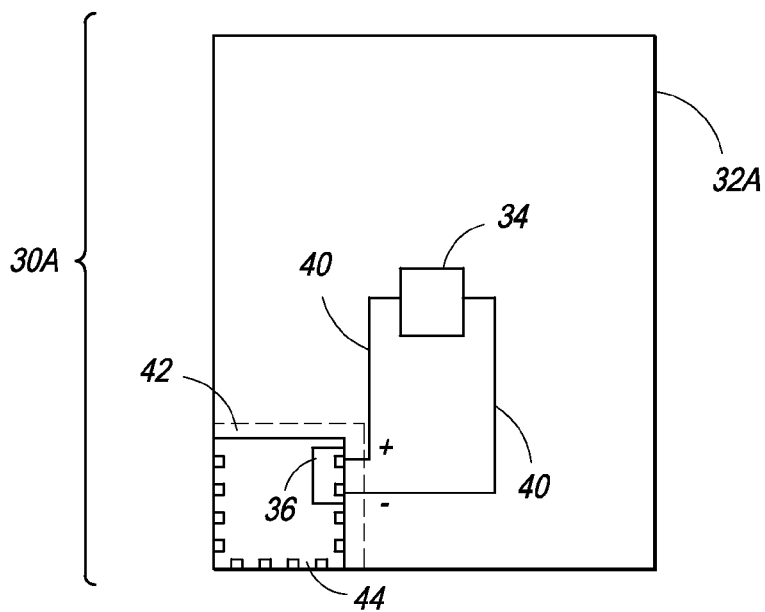


FIG. 6

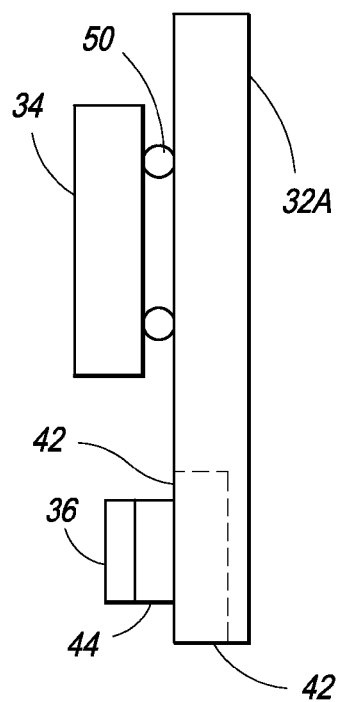


FIG. 6A

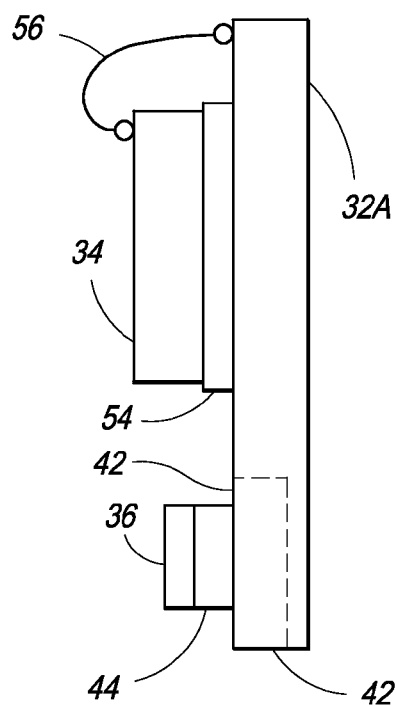


FIG. 6B

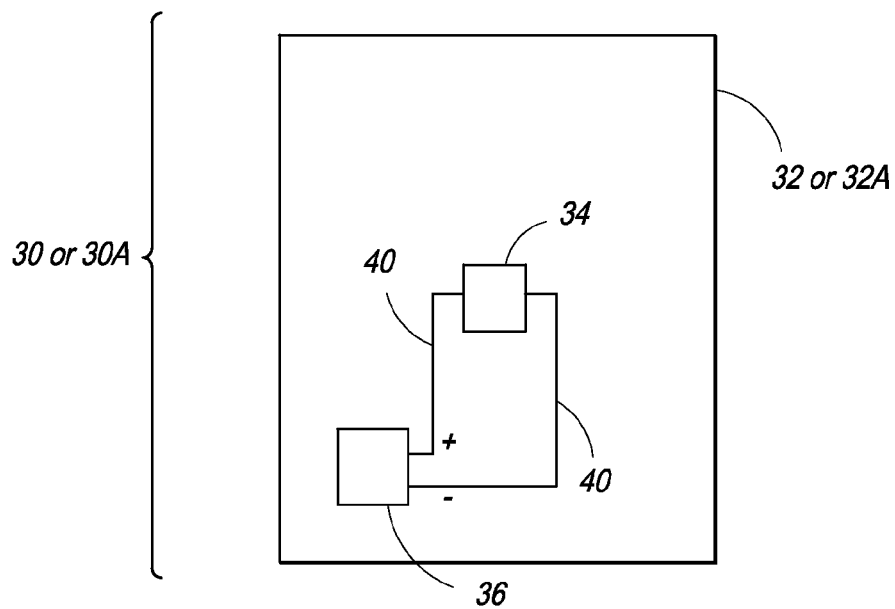


FIG. 7

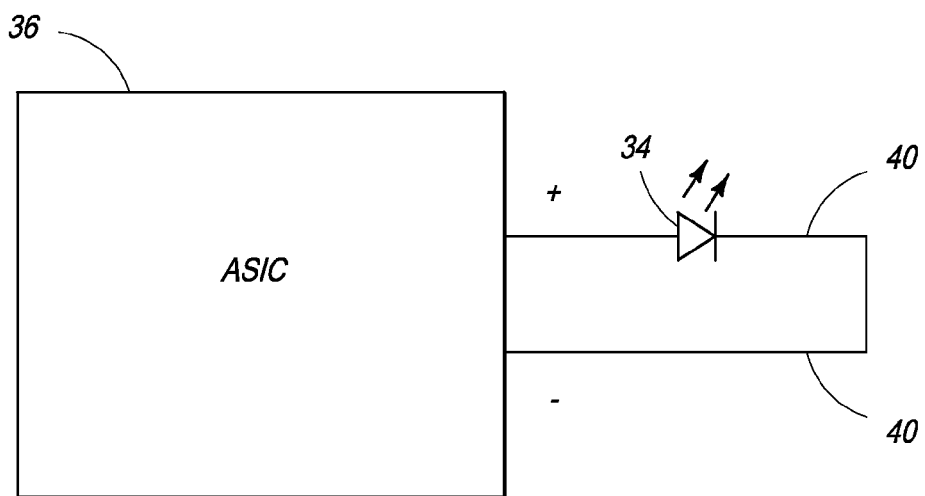
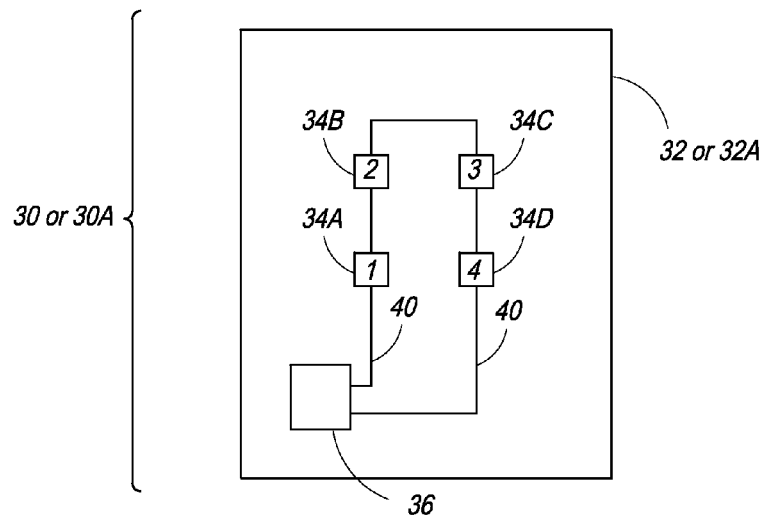
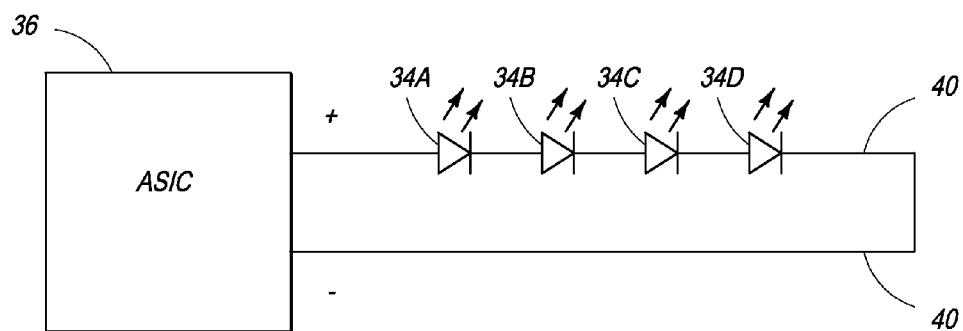


FIG. 7A





**FIG. 8**



**FIG. 8A**

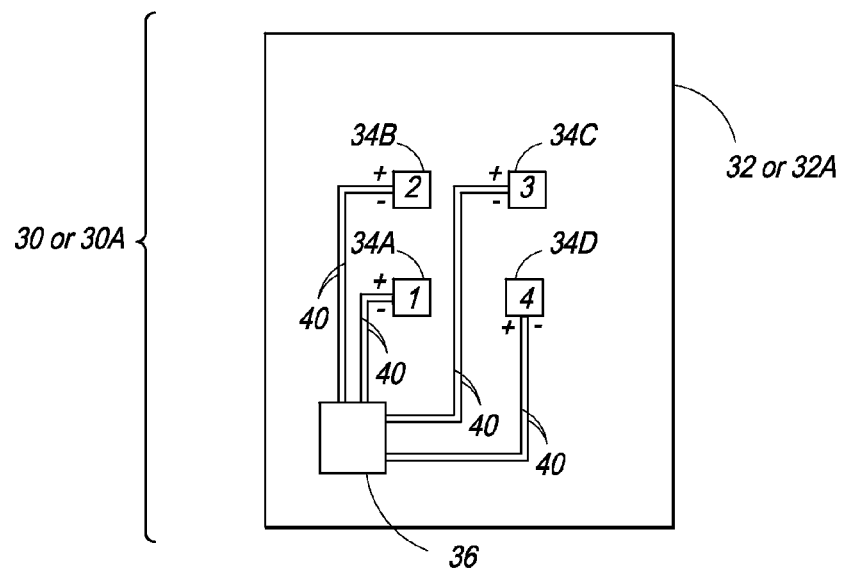


FIG. 9

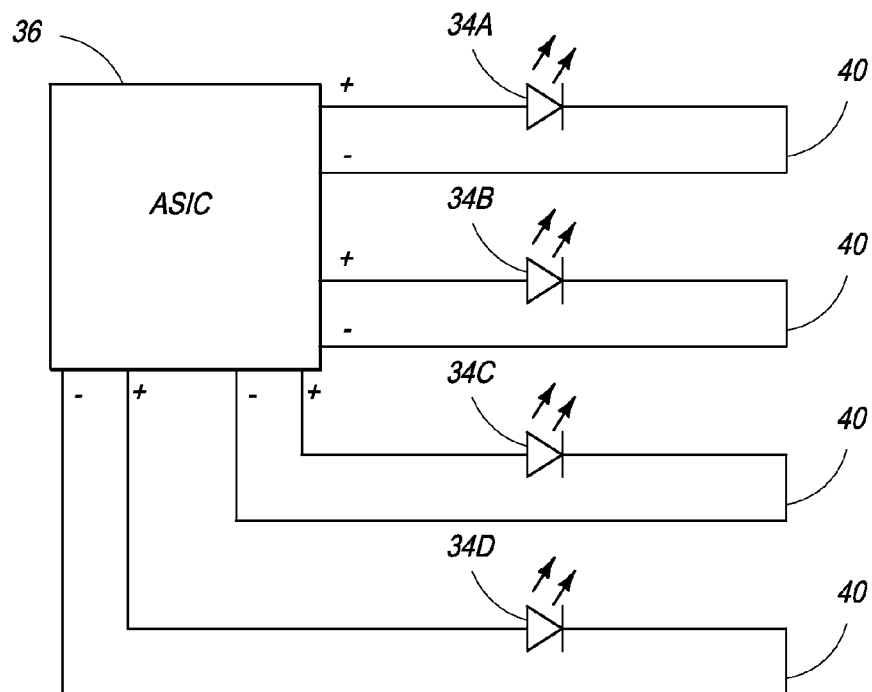


FIG. 9A

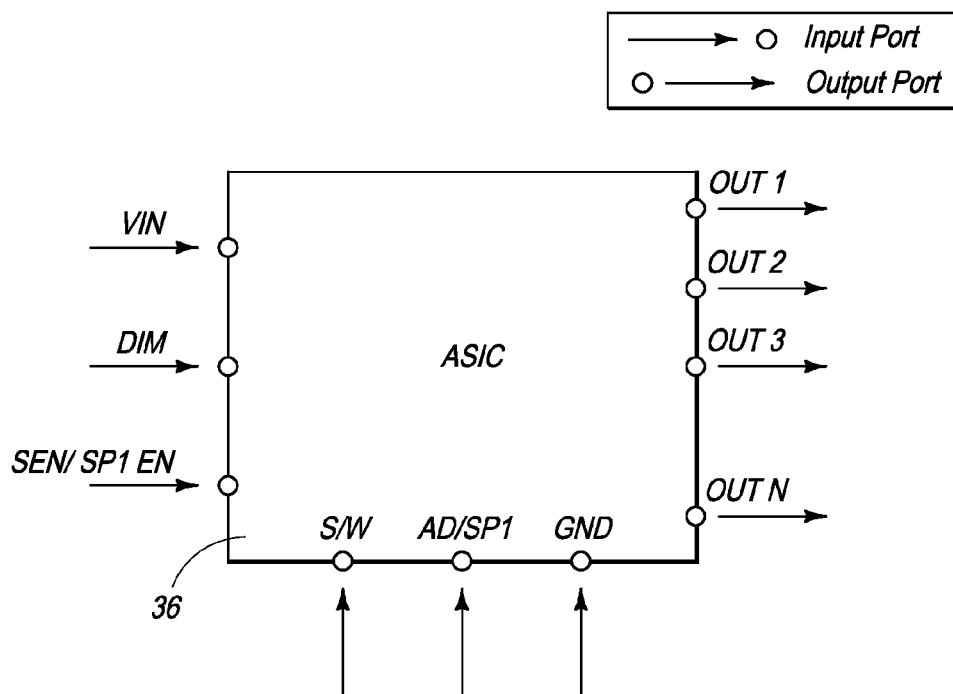


FIG. 10

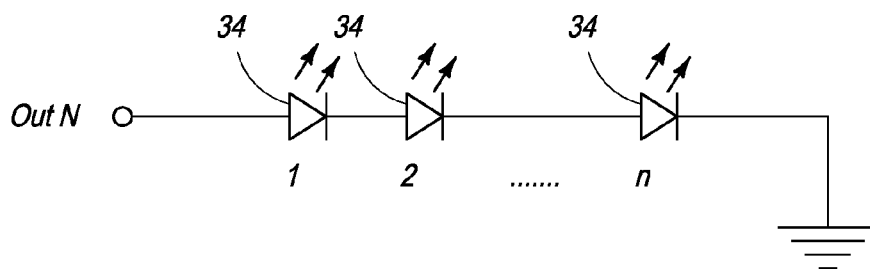


FIG. 10A

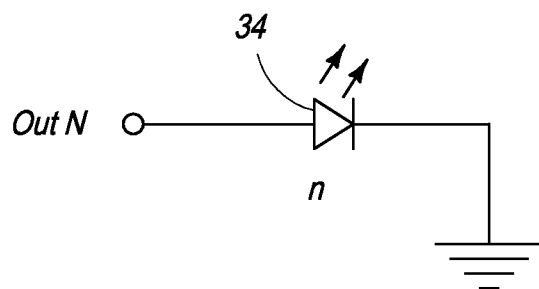


FIG. 10B

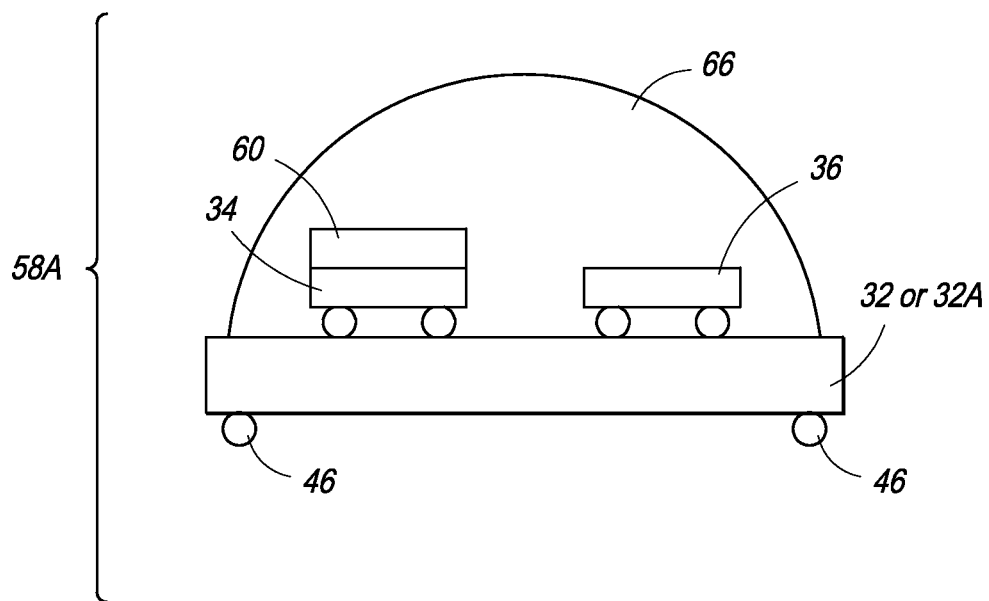


FIG. 11A

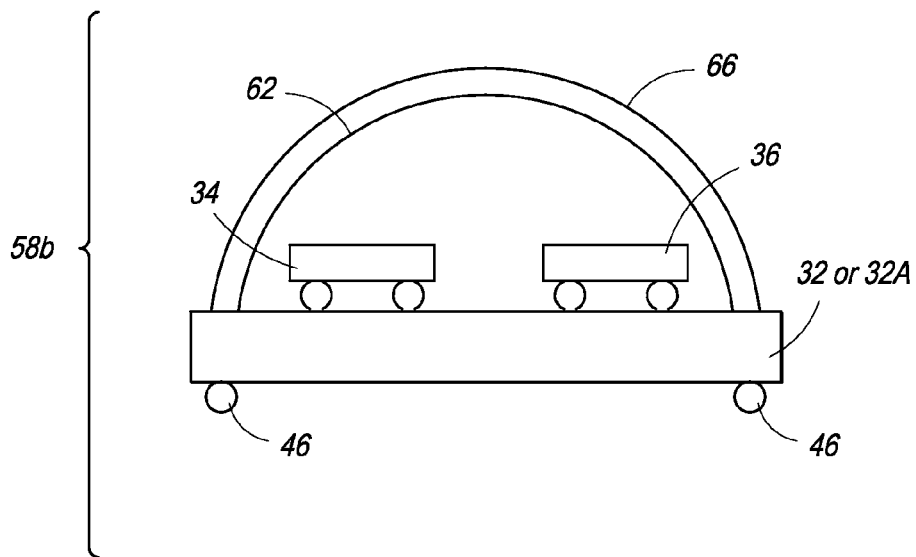


FIG. 11B

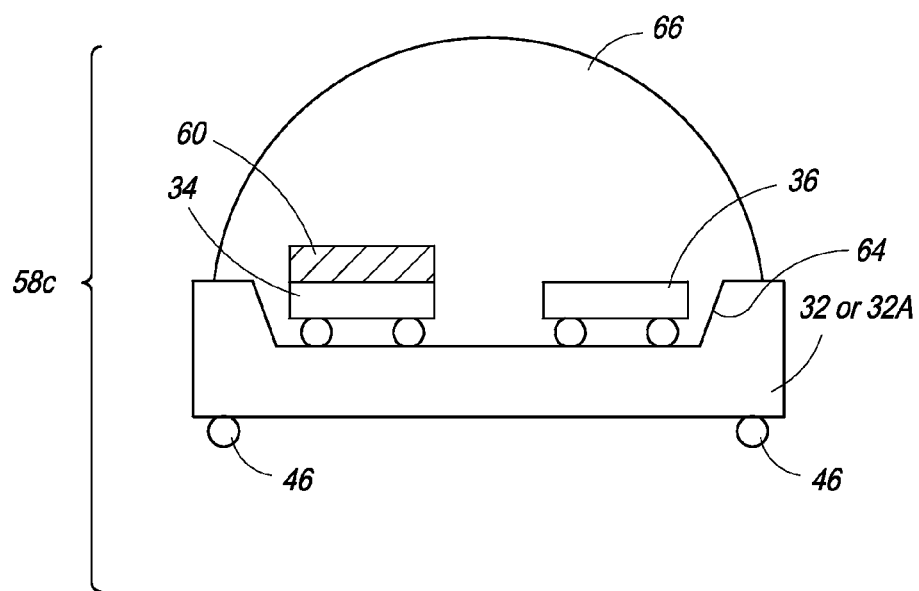


FIG. 11C

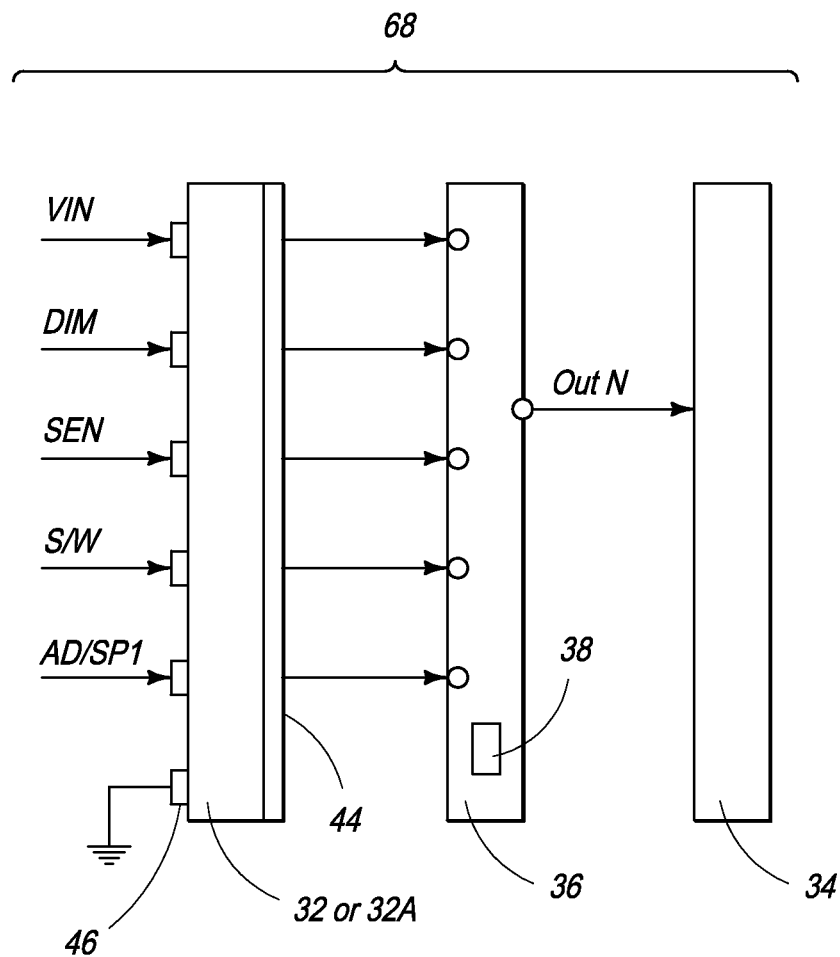


FIG. 12

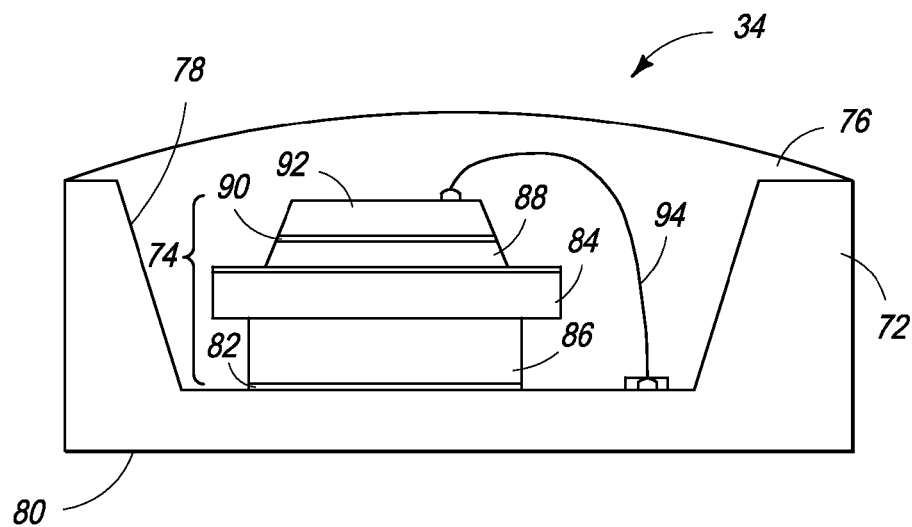


FIG. 13

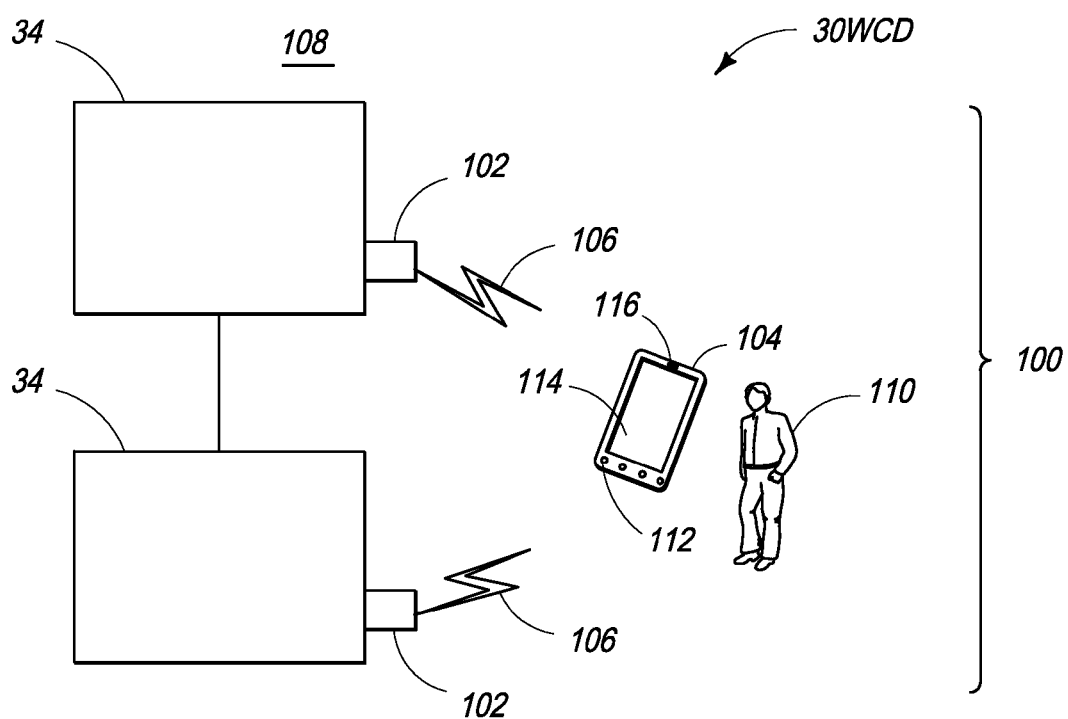


FIG. 14

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# **LIGHT EMITTING DIODE (LED) SYSTEM HAVING LIGHTING DEVICE AND WIRELESS CONTROL SYSTEM**

## **CROSS REFERENCE TO RELATED APPLICATIONS**

This application is a continuation-in-part of Ser. No. 13/309,718, filed on Dec. 2, 2011, U.S. Pat. No. 8,933,467 B2, which is a continuation-in-part of Ser. No. 12/540,523, filed on Aug. 13, 2009, U.S. Pat. No. 8,084,780 B2.

## **BACKGROUND**

This disclosure relates generally to light emitting diodes (LED) and more particularly to systems incorporating light emitting diodes (LEDs).

Light emitting diodes (LEDs) are used in a wide range of electronic devices such as displays, communication devices, and lamps. Advances in LED technology have improved the efficiency and service life of light emitting diodes (LEDs), and have made them smaller and lighter. However, most advances have been directed to the structure and function of the light emitting diodes (LEDs), rather than the associated LED systems. Light emitting diodes (LEDs) are typically part of a LED system that includes driver circuitry and associated electronic devices such as resistors, capacitors, diodes and circuit boards.

FIG. 1 illustrates a prior art LED circuit 10. The prior art LED system 10 includes a LED driver IC 12, and two light emitting diode (LED) chips 14 in electrical communication with the LED driver IC chip 12. The LED driver IC 12 is configured to provide driver and functionality circuits for the light emitting diode (LED) chips 14. The LED driver IC 12 includes a VIN pin, a SEN pin, a DIM pin, a SW pin and a GND pin. The LED system 10 also includes various electronic components including resistors, capacitors, a Schottky diode, and an inductor configured substantially as shown. The LED system 10 requires a relatively complex manufacturing process to mount and interconnect all of the electronic elements. In addition, relatively large amounts of current and power are required to drive the electronic elements, which generates a large amount of heat.

In view of the foregoing, improved LED systems are needed in the art, which are more efficient than prior art LED systems. However, the foregoing examples of the related art and limitations related therewith, are intended to be illustrative and not exclusive. Other limitations of the related art will become apparent to those of skill in the art upon a reading of the specification and a study of the drawings.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Exemplary embodiments are illustrated in the referenced figures of the drawings. It is intended that the embodiments and the figures disclosed herein are to be considered illustrative rather than limiting.

FIG. 1 is an electrical schematic diagram of a prior art LED system;

FIG. 2 is a schematic plan view of a LED system having integrated components and smart functionality;

FIG. 3 is a schematic plan view of the LED system having additional functionality built into a semiconductor substrate;

FIG. 4 is a schematic bottom view of the LED system showing circuitry on the substrate;

FIG. 5 is a schematic plan view of the LED system equivalent to FIG. 2;

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FIG. 5A is a schematic side elevation view of FIG. 5 illustrating a first mounting arrangement for an application specific integrated circuit (ASIC) and (LED) chip on the substrate;

FIG. 5B is a schematic side elevation view of FIG. 5 illustrating a second mounting arrangement for an application specific integrated circuit (ASIC) and (LED) chip on the substrate;

FIG. 6 is a schematic plan view of the LED system having additional functionality equivalent to FIG. 3;

FIG. 6A is a schematic side elevation view of FIG. 6 illustrating a first mounting arrangement for an application specific integrated circuit (ASIC) and (LED) chip on the substrate;

FIG. 6B is a schematic side elevation view of FIG. 6 illustrating a second mounting arrangement for an application specific integrated circuit (ASIC) and (LED) chip on the substrate;

FIG. 7 is a schematic plan view of the LED system equivalent to FIG. 2 or FIG. 3;

FIG. 7A is a schematic electrical diagram of the LED system of FIG. 7;

FIG. 8 is a schematic plan view of the LED system having multiple LED chips electrically connected in series;

FIG. 8A is a schematic electrical diagram of the LED system of FIG. 8;

FIG. 9 is a schematic plan view of the LED system having multiple LED chips electrically connected in parallel;

FIG. 9A is a schematic electrical diagram of the LED system of FIG. 9;

FIG. 10 is an electrical schematic diagram of the application specific integrated circuit (ASIC) of the LED system;

FIG. 10A is an electrical schematic diagram of a first output configuration of the application specific integrated circuit (ASIC) of the LED system;

FIG. 10B is an electrical schematic diagram of a second output configuration of the application specific integrated circuit (ASIC) of the LED system;

FIG. 11A is a schematic cross sectional view a first encapsulated package for the LED system;

FIG. 11B is a schematic cross sectional view a second encapsulated package for the LED system;

FIG. 11C is a schematic cross sectional view a third encapsulated package for the LED system;

FIG. 12 is an electrical schematic diagram of a LED integrated circuit formed by the LED system;

FIG. 13 is a schematic cross sectional view of a light emitting diode (LED) of the LED system; and

FIG. 14 is a schematic cross sectional view of a light emitting diode (LED) system having a lighting device and a wireless control system.

## **DETAILED DESCRIPTION**

Referring to FIG. 2, a LED system 30 includes a substrate 32, a light emitting diode (LED) 34 mounted to the substrate 32, and an application specific integrated circuit (ASIC) die 36 mounted to the substrate 32 in electrical communication with the light emitting diode (LED) 34. Although the LED system 30 includes only one application specific integrated circuit (ASIC) die 36, it is to be understood that the LED system can include a plurality of application specific integrated circuit (ASIC) dice 36. The substrate 32 functions as a mounting substrate, and also provides functionality for operating the light emitting diode (LED) 34 and the application specific integrated circuit (ASIC) die 36 as an integrated assembly. The light emitting diode (LED) 34 can comprise a



conventional LED fabricated using known processes. Suitable light emitting diodes (LEDs) are commercially available from SEMILEDS, INC. located in Boise, Id., and Miao-Li County, Taiwan, R.O.C. The application specific integrated circuit (ASIC) die **36** can comprise a semiconductor die having application specific integrated circuits **38** formed therein.

The light emitting diode (LED) **34** can comprise a Group-III nitride based material such as GaN, InGaN, AlGaIn, AlInGaIn or other (Ga, In or Al) N-based materials. In addition, the doped and active layers of the light emitting diode (LED) **34** can be formed on a carrier substrate made of a suitable material such as silicon (Si), silicon carbide (SiC) or sapphire (Al<sub>2</sub>O<sub>3</sub>). For example, SEMILEDS, INC. manufactures ultra thin vertical light emitting diodes (VLED) under the trademark MvpLED™. U.S. Pat. No. 7,723,718, entitled "Epitaxial Structure For Metal Devices", which is incorporated herein by reference, discloses methods for fabricating vertical light emitting diodes (VLED).

Referring to FIG. 13, the light emitting diode (LED) **34** is shown separately. However, it is to be understood that this configuration for the light emitting diode (LED) **34** is merely exemplary, and other configurations can be employed. The light emitting diode (LED) **34** includes a device substrate **72**, a vertical light emitting diode (VLED) die **74** mounted to the device substrate **74**, and an electrically insulating, light transmissive passivation layer **76** which encapsulates the light emitting diode (VLED) die **74**. For illustrative purposes in FIG. 13, the light emitting diode (LED) **34** is shown with only one vertical light emitting diode (VLED) die **74** mounted to the device substrate **72**. However, in actual practice the light emitting diode (LED) **34** can include a plurality of vertical light emitting diode (VLED) dice **74** mounted to the device substrate **72**, and arranged in a desired array to form an optoelectronic device, such as an LED display. The device substrate **72** can comprise a semiconductor material, such as silicon (Si), or another material, such as GaAs, SiC, AlN, Al<sub>2</sub>O<sub>3</sub>, or sapphire. The device substrate **72** can include a cavity **78** wherein the vertical light emitting diode (VLED) die **74** is mounted, and a back side **80**. An electrically conductive die attach layer **82** can be used to attach the vertical light emitting diode (VLED) die **74** to the substrate **72**.

Still referring to FIG. 13, the vertical light emitting diode (VLED) die **74** can be fabricated as disclosed in U.S. application Ser. No. 12/983,436 entitled "Vertical Light Emitting Diode (VLED) Die And Method Of Fabrication", which is incorporated herein by reference. The vertical light emitting diode (VLED) die **74** includes a first metal **84**; a second metal **86**; a p-type semiconductor layer **88** on the first metal **84**; a multiple quantum well (MQW) layer **90** on the p-type semiconductor layer **88**; and an n-type semiconductor layer **92** on the multiple quantum well (MQW) layer **90**. A preferred material for the p-type semiconductor layer **88** comprises p-GaN. Other suitable materials for the p-type semiconductor layer **88** include AlGaIn, InGaIn and AlInGaIn. A preferred material for the n-type semiconductor layer **92** comprises p-GaN. Other suitable materials for the n-type semiconductor layer **92** include AlGaIn, InGaIn and AlInGaIn. The multiple quantum well (MQW) layer **90** can comprise a semiconductor material, such as GaAs, sandwiched between two layers of a semiconductor material, such as AlAs having a wider bandgap. Wire bonded wires **94** electrically connect the n-type semiconductor layer **92** to electrodes on the substrate **72** and the vertical light emitting diode (VLED) die **74**.

Referring again to FIG. 2, the substrate **32** includes a front side (circuit side) having conductors **40** formed thereon, which electrically connect the application specific integrated circuit (ASIC) die **36** to the light emitting diode (LED) **34**. As

will be further explained, the application specific integrated circuit (ASIC) die **36** and the light emitting diode (LED) **34** can be mounted to the substrate using a suitable technique such as flip chip or C4 bonding. The substrate **32** can comprise silicon, or another semiconductor material such as gallium arsenide, and the conductors **40** can be fabricated using well known semiconductor fabrication processes. As another example, the substrate **32** can comprise silicon carbide (SiC) or sapphire (Al<sub>2</sub>O<sub>3</sub>). Alternately, the substrate **32** can comprise a ceramic material, a printed circuit board (PCB) material, a metal core printed circuit board (PCB), an FR-4 printed circuit board (PCB), a metal lead frame, an organic lead frame, a silicon submount substrate, or any packaging substrate used in the art.

The substrate **32** can have any polygonal shape (e.g., square, rectangular) and any suitable size. In addition, the substrate **32** can be die-sized, such that the LED system **30** has a chip scale size similar to that of a chip scale package (CSP) or a system on a chip (COS). Alternately, the substrate **32** can be wafer sized such that a wafer scale system is provided.

Referring to FIG. 3, an alternate embodiment LED system **30A** is substantially similar to the LED system **30** (FIG. 2), but includes a substrate **32A** configured to provide additional electrical functionality. In particular, the substrate **32A** comprises a semiconductor material having a segment **42** formed with application specific integrated circuits (ASICs) **44** configured to perform additional electrical functions. The application specific integrated circuits (ASICs) **44** can include semiconductor components, circuits, and base materials integrated into the substrate **32A**. For example, the application specific integrated circuits (ASICs) **44** can include resistors, diodes (p-n), capacitors, gates, metal-oxide field effect transistors (MOSFET), and flip flops. The application specific integrated circuits (ASICs) **44** can be combined with the integrated circuits in the application specific integrated circuit (ASIC) die **36** to provide smart on-board control of the light emitting diode (LED) **34**.

The semiconductor substrate **32A** can comprise a portion of a semiconductor wafer having the application specific integrated circuits (ASICs) **44** formed therein using conventional semiconductor fabrication techniques such as implanting, photopatterning. The light emitting diode (LED) **34** can be mounted to a blank portion of the substrate **32A** spaced from the application specific integrated circuits (ASICs) **44**, and electrically connected to the application specific integrated circuits (ASICs) **44** using suitable connecting elements and interconnects.

As shown in FIG. 4, the substrate **32** or **32A** includes a back side **48** having an array of contacts **46** in electrical communication with the application specific integrated circuit (ASIC) die **36** (FIG. 2), and with the application specific integrated circuits (ASICs) **44** (FIG. 3). The contacts **46** function as the terminal contacts for connecting the LED system **30** (FIG. 2) or **30A** (FIG. 3) to the outside world including other electronic devices and circuitry. The contacts **46** can comprise bumps or pads made of a bondable material such as solder, metal or a conductive polymer, configured for bonding to corresponding electrodes on a module substrate, circuit board or other support substrate. In addition, the contacts **46** can be arranged in a suitable dense area array, such as a ball grid array (BGA) or fine ball grid array (FBGA). Further, the contacts **46** can be electrically connected to the application specific integrated circuit (ASIC) die **36** (FIG. 2) and to the application specific integrated circuits (ASICs) **44** (FIG. 3) using suitable elements, such as interconnects, conductive traces, redistribution conductors and conductive vias formed on the substrate **32** or **32A**.

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The contacts **46** can be configured to integrate and expand the electrical functions of the application specific integrated circuit (ASIC) die **36** (FIG. 2), the application specific integrated circuits (ASICs) **44** (FIG. 3), and the light emitting diode (LED) **34** (FIG. 2), and to provide smart control for the LED system **30** (FIG. 2) or **30A** (FIG. 3). For example, the contacts **46** can be configured as: a.) multi purpose input-output ports; b.) power inputs (AC or DC) for driving the LED system **30** or **30A**; c.) dimming control ports; d.) current setting ports; e.) feedback sensor ports; f.) communication ports; and g.) common ground ports. In addition, the application specific integrated circuits (ASICs) **44** (FIG. 3), and the light emitting diode (LED) **34** (FIG. 2) form an integrated LED circuit.

Referring to FIGS. 5, 5A and 5B, an exemplary mounting arrangement for mounting the light emitting diode (LED) **34** and the application specific integrated circuit (ASIC) die **36** to the substrate **32** in LED system **30** are illustrated. In FIG. 5A, the LED chip **34** has a p-, n-same side configuration and is mounted in a chip-on-board (COB) configuration using interconnects **50**, and a flip chip bonding method such as C4 (controlled collapse chip connection). Similarly, the application specific integrated circuit (ASIC) die **36** includes interconnects **52** and is flip chip mounted to the substrate **32** in a chip on board configuration. In FIG. 5B, the LED chip **34** has a p-, n-different side configuration and is mounted to the substrate **32** using a die attach bonding layer **54** (e.g., solder, silver epoxy), and a wire bonded wire **56** bonded to contacts on the LED chip **34** and the substrate **32**.

Referring to FIGS. 6, 6A and 6B, an exemplary mounting arrangement for mounting the light emitting diode (LED) **34** and the application specific integrated circuit (ASIC) die **36** to the substrate **32A** in LED system **30A** are illustrated. In FIG. 6A, the LED chip **34** has a p-, n-same side configuration and is mounted in a chip-on-board (COB) configuration using interconnects **50**, and a flip chip bonding method such as C4 (controlled collapse chip connection). The application specific integrated circuit (ASIC) die **36** can be flip chip mounted to the application specific integrated circuits **44** on the substrate **32A** in a chip on board configuration substantially as previously described. In FIG. 6B, the LED chip **34** has a p-, n-different side configuration and is mounted to the substrate **32A** using a die attach bonding layer **54** (e.g., solder, silver epoxy), and a wire bonded wire **56** bonded to contacts on the LED chip **34** and the substrate **32A**.

Referring to FIGS. 7 and 7A, an exemplary electrical configuration for the application specific integrated circuit (ASIC) die **36** and the light emitting diode (LED) **34** for the LED system **30** or **30A** are illustrated. As shown in FIG. 7A, the light emitting diode (LED) **34** can be electrically connected via the conductors **40** to ground pins on the application specific integrated circuit (ASIC) die **36**. Alternately, the light emitting diode (LED) **34** can be connected to a dedicated ground pin on the substrate **32** or **32A**.

Referring to FIGS. 8 and 8A, the LED system **30** or **30A** can also include multiple light emitting diodes (LEDs) **34A-34D** mounted directly to the substrate **32** or **32A**. The light emitting diodes (LEDs) **34A-34D** can all be configured to produce the same wavelengths and colors of light (e.g., red, green, blue, white, UV, laser, IR), or can be configured to produce different combinations thereof. For example, a first light emitting diode (LED) **34A** can produce white light, a second light emitting diode (LED) **34B** can produce green light, a third light emitting diode (LED) **34C** can produce blue light, and a fourth light emitting diode (LED) **34D** can produce red light. In addition, the application specific integrated circuit (ASIC) die **36**, and the application specific integrated

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circuits **44** (FIG. 3) can be adapted to provide smart color control for the light emitting diodes (LEDs) **34A-34D**. As shown in FIG. 8A, the light emitting diodes (LEDs) **34A-34D** can be electrically connected in series and grounded to ground pins on the application specific integrated circuit (ASIC) die **36**. Alternately, the light emitting diodes (LEDs) **34A-34D** can be connected to a dedicated ground pin on the substrate **32** or **32A**.

Referring to FIGS. 9 and 9A, the LED system **30** or **30A** can also include multiple light emitting diodes (LEDs) **34A-34D** electrically connected in parallel. As another alternative, the light emitting diodes (LEDs) **34A-34D** can be electrically connected in multiple parallel strings with each string containing a plurality of light emitting diodes (LEDs) **34** connected in series.

Referring to FIGS. 10, 10A and 10B, electrical characteristics of the LED system **30** or **30A** are illustrated. FIG. 10 illustrates an input/output configuration for the application specific integrated circuit (ASIC) die **36**. In general, the input/output configuration and the application specific integrated circuits of the application specific integrated circuit (ASIC) die **36** are configured to integrate the light emitting diode **34** and the application specific integrated circuit (ASIC) die **36** into an integrated assembly. FIG. 10A illustrates an output configuration for the application specific integrated circuit (ASIC) die **36** with a string of light emitting diodes (LED) **34** electrically connected in series to ground. FIG. 10B illustrates an output configuration for the application specific integrated circuit (ASIC) die **36** with a single light emitting diode (LED) **34** electrically connected to ground.

Table 1 describes the input port configuration for the application specific integrated circuit (ASIC) die **36**.

TABLE 1

INPUT PORT CONFIGURATION	
PORT	PORT DESCRIPTION
Vin	Power Source input for LED Systems. Power input is enable for: a) DC Voltage Range 1.5 VDC-60 VDAC a) AC Voltage Range 90 VAC-264 VAC/50 Hz-60 Hz
DIM	This is dimming input control port. Dimming is allowed from 0% to 100% brightness. Allow dimming type: a) OVDC to 10 VDC Type Method b) Pulse Width Modulation c) Convention Triac Dimmer
SEN	This port has 2 functions 1) Constant Current Output to LED setting. 2) Enable Serial Write to Flash/ROM for White Balance Setting
SPI EN	This port is to use for Soft Turn ON/OFF purpose
SW	This port has 2 functions: 1) Multi-purpose A/D When SPI En is disable, A/D port function will be enable
A/D	2) SPI When SPI EN Port is Enable, LED Brightness Tuning/White Balance Parameter can be burn into Flash/ROM
SPI	Common
GDN	Some features of LED system 30 or 30A include: Adjustable LED (load) current LED Output port current can be scaled to multiple ratio for the purpose of: White Balancing (for White or RGB applications) or White Color Coordinate Tuning Brightness Calibration Soft Turn On-Off Dimmable Dimming - PWM Dimming - 0-10 V Dimming - TRAC Failsafe System Build in Safety Protection Over Temperature when Tj > 150° C.

TABLE 1-continued

INPUT PORT CONFIGURATION	
PORT	PORT DESCRIPTION
	Over Voltage/Overload
	Under voltage lockout
	Reverse polarity protection

Referring to FIGS. 11A-11C, different packaging configurations for the LED system 30 or 30A are illustrated. In FIG. 11A, an LED package 58A includes the substrate 32 or 32A, the application specific integrated circuit (ASIC) die 36, and the light emitting diode (LED) 34, substantially as previously described. In addition, the light emitting diode (LED) 34 can include a phosphor layer 60 for producing white light. The LED package 58A also includes a polymer lens 66 on the substrate 32 or 32A, which encapsulates the LED system 30 or 30A. The polymer lens 66 can comprise a suitable polymer such as epoxy formed by molding or other suitable process.

In FIG. 11B, an LED package 58B includes the substrate 32 or 32A, the application specific integrated circuit (ASIC) die 36, and the light emitting diode (LED) 34, substantially as previously described. The LED package 58A also includes a polymer lens 66 on the substrate 32 or 32A which encapsulates the LED system 30 or 30A. In this embodiment, the polymer lens 66 also includes a phosphor layer 62 for producing white light.

In FIG. 11C, an LED package 58C includes the substrate 32 or 32A, the application specific integrated circuit (ASIC) die 36, and the light emitting diode (LED) 34, substantially as previously described. In this embodiment, the substrate 32 or 32A also includes a reflective recess 64 wherein the application specific integrated circuit (ASIC) die 36, and the light emitting diode (LED) 34 are mounted.

Referring to FIG. 12 an electrical schematic of an LED integrated circuit 68 formed by the LED system 30 or 30A is illustrated. The LED integrated circuit 68 includes the contacts 46 on the substrate 32 or 32A. The LED integrated circuit 68 can also include the application specific integrated circuits 44 on the substrate 32A. The LED integrated circuit 68 also includes the application specific integrated circuits 38 in the application specific integrated circuit (ASIC) die 36. The LED integrated circuit 68 also includes the light emitting diode 34. Because the LED integrated circuit 68 has integrated elements power consumption and heat generation are less than with the prior art LED circuit 10 (FIG. 1). In addition, the LED system 30 or 30A can be made smaller such that a chip scale system can be provided.

Referring to FIG. 14, a wireless control device light emitting diode (LED) system 30WCD includes one or more light emitting diodes (LED) 34, or other lighting devices, configured to provide lighting in an area 108, and a wireless control system 100 configured to control the light emitting diodes (LED) 34. The wireless control system 100 includes one or more transmitter/receiver devices 102 in signal communication with the light emitting diode (LED) 34. The wireless control system 100 also includes a wireless control device 104 operable by a user 110 for sending signals 106 to the transmitter/receiver devices 102 for controlling the light emitting diode (LED) 34. The signals 106 from the wireless control device 104 to the transmitter/receiver devices 102 are termed herein as "input signals". The wireless control device 104 is also operable by the user 110 to receive signals 106 from the transmitter/receiver device 102 for indicating a status of the light emitting diodes (LED) 34. The signals 106

from the transmitter/receiver devices 102 to the wireless control device 104 are termed herein as "output signals".

The transmitter/receiver devices 102 can comprise wireless or wire connected components in signal communication with the light emitting diodes (LED) 34 via wireless or wired transmission. For example, each light emitting diode (LED) 34 can include an integral transmitter/receiver device 102 configured as an element thereof. Alternately, the transmitter/receiver devices 102 can comprise stand alone devices separate from the light emitting diodes (LED) 34 and configured to control one or more light emitting diodes (LED) 34. The transmitter/receiver devices 102 are configured to receive the input signals 106 from the wireless control device 104 for controlling the light emitting diodes (LED) 34. In addition, the transmitter/receiver devices 102 are also configured to send output signals 102 to the wireless control device 104 for indicating the status of the light emitting diodes (LED) 34.

The wireless control device 104 can comprise a stand alone unit or can be contained on a computer or a mobile communications device, such as a mobile telephone, smart telephone, portable computer, "IPAD" or "IPHONE". The wireless control device 104 can also include an input device 112, such as a key pad or voice control, configured to receive user input for controlling the signals 106, and a display device 114 configured to display data indicating the status of the wireless control device 104 and the light emitting diodes (LED) 34. Optionally, the wireless control device 104 can include an automated input device, such as an automated program 116 for controlling the signals 106. The wireless control device 104 or automated program 116 can also be pass word protected such that only an authorized user 110 can activate or provide input to the wireless control device 104. For example, the signals 106 can be used to turn the light emitting diodes (LED) 34 on and off, separately or in unison, and to control the brightness and the color of the light emitting diodes (LED) 34, separately or in unison. In addition, the automated program 116 can provide a map for controlling the light emitting diodes (LED) 34. Further, the automated program 116 and the display device 114 can be configured to indicate the status of the light emitting diodes (LED) 34 such as on/off, dimming level, and color level.

A method for controlling the light emitting diode (LED) system 30WCD can include the steps of: providing at least one light emitting diode (LED) 34 configured to light an area 108; providing a transmitter/receiver device 102 in signal communication with the light emitting diode (LED) 34 configured to transmit and receive signals 106; and providing a wireless control device 104 in signal communication with the transmitter/receiver device 102 configured to transmit input signals 106 to the transmitter/receiver device 102 for controlling the light emitting diode (LED) 34 and to receive output signals 106 from the transmitter/receiver device 102 to indicate a status of the light emitting diode (LED) 34. The method also includes the steps of: sending the input signals 106 from the wireless control device 104 to the transmitter/receiver device 102 for controlling the light emitting diodes (LED) 34; and sending the output signals 106 from the transmitter/receiver device 102 to the wireless control device 104 for indicating a status of the light emitting diode (LED). The method can also include the step of controlling the wireless control device 104 using an automated program 116, and the step of activating the wireless control device 104 using a password.

Thus the disclosure describes improved LED systems. While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize certain modifications, permutations, additions and subcombinations thereof. It is therefore intended that the following

appended claims and claims hereafter introduced are interpreted to include all such modifications, permutations, additions and sub-combinations as are within their true spirit and scope.

What is claimed is:

1. A lighting system comprising:  
at least one light emitting diode (LED) configured to provide lighting in an area, the light emitting diode (LED) comprising an integral transmitter/receiver device configured as an element thereof; and  
a wireless control system configured to control the light emitting diode (LED), the wireless control system comprising a wireless control device in wireless communication with the transmitter/receiver device on the light emitting diode (LED), the wireless control device operable by a user to send input signals to the transmitter/receiver device on the light emitting diode (LED) for controlling the light emitting diode (LED) and to receive output signals from the transmitter/receiver device on the light emitting diode (LED) for indicating a status of the light emitting diode (LED).
2. The system of claim 1 wherein the wireless control system comprises a computer or a mobile communications device comprising an input device for receiving input from the user and a display device configured to indicate the status of the light emitting diode (LED) to the user.
3. The system of claim 2 wherein the computer or mobile communications device is operable by an automated program to control the input signals and the output signals.
4. The system of claim 3 wherein the program is configured for activation by a password inputted by the user.
5. A light emitting diode (LED) system comprising:  
at least one light emitting diode (LED) configured to provide lighting in an area the light emitting diode (LED) comprising an integral transmitter/receiver device configured as an element thereof; and  
a wireless control system configured to control the light emitting diode (LED) the wireless control system comprising a wireless control device comprising an input device and a display device operable by a user, the wireless control device in wireless communication with the transmitter/receiver device on the light emitting diode (LED), the wireless control device configured to send input signals to the transmitter/receiver device on the light emitting diode (LED) responsive to user input to the input device for controlling the light emitting diode (LED) and to receive output signals for display on the display device to indicate a status of the light emitting diode (LED).

6. The light emitting diode (LED) system of claim 5 wherein the wireless control device comprises a computer.
7. The light emitting diode (LED) system of claim 5 wherein the wireless control device comprises a mobile communications device.
8. The light emitting diode (LED) system of claim 5 wherein the wireless control device is operable by an automated program to control the signals.
9. The light emitting diode (LED) system of claim 5 wherein the wireless control device is activated by a password inputted by the user.
10. A method for controlling a light emitting diode (LED) system comprising:  
providing at least one light emitting diode (LED) configured to light an area, the light emitting diode (LED) comprising an integral transmitter/receiver device configured as an element thereof;  
providing a wireless control device in wireless signal communication with the transmitter/receiver device on the light emitting diode (LED), the wireless control device configured to transmit input signals to the transmitter/receiver device on the light emitting diode (LED) for controlling the light emitting diode (LED) and to receive output signals from the transmitter/receiver device on the light emitting diode (LED) to indicate a status of the light emitting diode (LED);  
sending the input signals from the wireless control device to the transmitter/receiver device on the light emitting diode (LED) for controlling the light emitting diode (LED); and  
sending the output signals from the transmitter/receiver device on the light emitting diode (LED) to the wireless control device for indicating a status of the light emitting diode (LED).
11. The method of claim 10 further comprising controlling the wireless control device using an automated program.
12. The method claim 10 further comprising activating the wireless control device using a password.
13. The method of claim 10 wherein the wireless control device comprises an input device for configuring the input signals and a display device for displaying the status of the light emitting diode (LED).
14. The method of claim 10 wherein the wireless control system comprises a computer or a mobile communications device.
15. The method of claim 10 wherein the wireless control system is operable by an automated program to control the signals.

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